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ABSTRACT

This study explored the teaching processes in mathematics education for adults and how they are shaped by certain social and institutional forces. The study addressed three broad questions: (1) What happens in adult mathematics classrooms? (2) What do these phenomena mean for those involved as teachers or learners? and (3) In what ways do "frame factors" (factors beyond the teacher's control) affect teaching processes? Data were collected in various ways: document collection, surveys of teachers' and adult learners' attitudes, repeated semi-structured interviews with teachers and learners, and extensive ethnographic observations in several mathematics classes. From observations of actual episodes and activities in mathematics classrooms, several key themes were identified: (1) within the classroom the teacher's role was paramount--almost all decisions about classroom activities were made by teachers, and the learners' influence was minimal; (2) the teacher and the textbooks adopted the role of supreme authorities of mathematical knowledge; (3) adult learners were assigned a passive role in their own education. (MKR)

# Teaching Mathematics to Adults

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## Background

The mathematical abilities of Americans regularly give cause for concern to government bodies, business and community leaders, and adult and mathematics educators. There is a strong consensus, amongst these groups, that the mathematical skills, awareness, and understanding of adult learners, whether high-school leavers or college graduates, have deteriorated alarmingly in recent years. Adults know less, understand less, have little facility with simple mathematical operations, and find difficulty in solving any but the shortest and simplest of mathematical problems.

So what? Millions of people appear to function perfectly well without ever needing to use much of the mathematics that they remember from school. No one claims to be particularly disadvantaged by a lack of mathematical abilities. In addition, many people see mathematics as an esoteric subject having little to do with their everyday lives. Indeed, mathematics commonly represents a body of ultimately abstract, objective and timeless truths, far removed from the concerns and values of humanity. If mathematics seems so tangential to everyday life, why is it such a problem if so many people can't do math very well?

Primarily it is a problem because of the societal and individual consequences of innumeracy. Numeracy--mathematical ability--is commonly recognized as a major determinant for job and career choices, and a key to economic productivity and success in modern, industrial societies. Numeracy, then, functions as "cultural capital." Hence, the extent of mathematical ability operates as a social filter, and access to social effectiveness and privilege is restricted to those with sufficient mathematical ability.

It doesn't start out that way. Indeed, numeracy is one of the major intended outcomes of schooling, and mathematics occupies a central position in virtually every school curriculum. But somehow, mathematics teaching fails to produce numerate adults. As Western society has become increasingly informationally and technologically saturated, the innumerate are increasingly disadvantaged--confused and manipulated by numbers, unable to critically assess assumptions and logical fallacies, and unable to participate as effective and informed citizens. For example, how often are adults prepared to take statistical information and their stated conclusions at face value? How many of us feel skilled enough to look beyond the numbers to interpret what the statistics mean? Of particular concern is the underlying pattern of inequity in adult numeracy; surveys of mathematical abilities show that performance is lower among working class, women, Hispanic, and Afro-American learners. So, mathematics is important if only because it is capable of empowering so many.

Why are adults' mathematical abilities as low as they are? The primary contributor appears to be the poor teaching in school mathematics classrooms (Frankenstein, 1981; Paulos, 1988). Traditionally, mathematics education is taught as an abstract and hierarchical series of objective and decontextualized facts, rules, and answers. Further, predominant teaching methods use largely passive, authoritarian, and individualizing techniques that depend on memorization, rote calculation, and frequent testing (Bishop, 1988). Knowledge is thus portrayed as largely separate from learners' thought processes, and mathematics education is experienced as a static, rather than dynamic process. Adults who do wish to upgrade their mathematical skills have access to a variety of courses run by local public sector educational bodies. It is unclear, however, if these courses are, in any way, adult-oriented, or merely reproduce the curricula and teaching methods so common in traditional K-12 mathematics. Given the rapid decline in adult numeracy, the nature of its social consequences, and the apparent inadequacy of current educational approaches to remedy it, this study of the teaching processes in adult mathematics classrooms is both timely and necessary.

## The Study

### Purpose

This study explored the teaching processes in mathematics education for adults and how they are shaped by certain social and institutional forces. Teaching processes include the selection of content to be taught; the choice of such techniques as lectures or groupwork; the expectations, procedures and norms of the classroom; and the complex web of interactions between teachers and learners, and between learners themselves. The study addressed three broad questions: (1) What happens in adult mathematics classrooms? (2) What do these phenomena mean for those involved as teachers or learners? and (3) In what ways do "frame factors" (factors beyond the teachers' control) affect teaching processes?

### Theoretical Framework

A large part of the context of teaching consists of the thinking, planning, and decision-making of teachers. Clark and Peterson (1986) developed a model that relates teachers' thoughts to their actions considering such aspects as teacher planning, the interaction between teachers' thoughts and decisions, and teachers' theories and beliefs. It is based on an interpretive perspective that addresses such questions as, for example, differences in meaning regarding learners' achievements, and the teacher's role in classroom interactions.

A thorough discussion of teaching processes must also include an understanding of factors that impinge upon such processes. Frame factor theory (Lundgren, 1981) analyzes the ways in which teaching processes are chosen, developed, and constrained by certain frames. Briefly, a frame is "any factor that limits the teaching process and is determined outside of the control of teacher or students" (p. 36). Examples of frames include physical settings, aspects of the curriculum such as the syllabus or the textbooks, and organizational arrangements such as the size of the class, the number of lessons, and the time available for teaching. Frame factor theory claims that teaching processes are governed by "the possible freedom of action which exists in a given situation" (p. 150), rather than

being causally determined. The frames mark out the limits that teaching processes can have; the actual teaching is conducted within these limits.

The theoretical framework of this study, therefore, links these two approaches and offers an analytical perspective that shows how teachers' thoughts and actions are circumscribed by factors beyond their control.

## Related Literature

Although extensive research examines mathematics education for children, there is little corresponding research on such education for adults (Gal, 1993). However, most published discussions of adults' mathematical abilities suggest that poor mathematics teaching in K-12 schools is a significant contributor to the high levels of adult innumeracy. Most of these discussions are written either from the viewpoint of government or industry leaders (e.g., National Research Council, 1989) or from that of university professors of mathematics (e.g., Paulos, 1988; Willoughby, 1990). These viewpoints overwhelmingly reflect either policy-making and managerial perspectives or the academic research interests of the profession. Further, they are often based on narrow technical and instrumental models of education that ignore much adult learning theory and the importance of such issues as self-concept, motivation, values, attitudes, and intentions in learning. What is clearly missing are the experiences and attitudes of those most intimately involved in mathematics education: adult learners and their teachers.

## Methods

The study was based in a typical setting for adult mathematics education: a community college providing a range of ABE-level mathematics courses for adults. Three introductory-level courses (each taught by different teachers) were selected and data collected from teachers and students in these courses, as well as material that related to the teaching and learning of mathematics within the college. The study used a variety of data collection methods in addition to document collection: surveys of teachers' and adult learners' attitudes, repeated semi-structured interviews with teachers and learners, and extensive ethnographic observations in several mathematics classes. Several lessons were video-recorded and later used as the basis for "stimulated recall" interviews with the teachers concerned. All interviews were tape-recorded and transcribed for subsequent data analysis. The complete data set was then coded and initial concepts and categories from the theoretical framework were linked into broader themes and patterns to develop increasingly complex concepts and assertions. Finally, the data set was again systematically searched for both disconfirming and confirming data to support all claims and assertions.

## Findings

From observations of actual episodes and activities in mathematics classrooms, several key themes were identified. First, within the classroom, the teacher's role was paramount. Almost all decisions about classroom activities were made by teachers; the learners' influence was minimal. Further, teachers made their choices with little consideration for the needs and interests of their learners. The overall goal for most teachers was to "cover the assigned material" without losing too many students along the way. Teachers appeared to make their decisions

largely to suit themselves, regardless of the needs of students, although they often described their decisions as being "in the students' best interests."

Teachers subtly reinforced the idea that mathematics is largely a difficult and intrinsically uninteresting subject, full of "tricks," and best tackled by motivation, hard work, and repeated practice. Only one method of learning mathematics was promoted: learn a rule, then apply it repeatedly until its use becomes almost automatic. This pedagogical approach was followed rigorously by teachers who, without exception, structured their lessons into a cyclic pattern of presentation, practice, and assessment. Teachers adopted a largely teacher-centered approach: they assumed that their own attitudes were common or preferred, they rarely asked students any questions or fostered a spirit of discovery, they "helped" the students to find right answers, they seldom checked student comprehension, they focused on errors, and they used complicated and often idiomatic language which often confused students (particularly non-native English speakers). Although the courses took place in a classroom--a social setting--teachers tended to work mostly with individual students, fostered competition, and limited the opportunities for student interaction and discussion.

Second, the teacher and the set textbooks adopted the role of supreme authorities of mathematical knowledge. Mathematics was transmitted through either the textbook or the teachers' explanations, and never presented as a subject to be created or investigated. Indeed, students were given few opportunities to explore mathematical concepts for themselves, and, when those opportunities occurred by chance, they were largely ignored by teachers. Consequently, students assumed that being successful in mathematics meant being adept at calculation regardless of knowing the reasons for making those calculations in the first place. Within each course, achievement was almost totally determined by regular assessment tests, with their form and content taken directly from the textbook. Teachers repeatedly stressed that such tests were essential preparation (either academically or vocationally) for the future, regardless of the specific goals of the students.

Third, adult learners were assigned a passive role in their own education. Adults entered the courses, initially cowed by both their lack of mathematical ability and by the unfamiliar academic environment, and were forced to take part in a series of activities that, although mathematically-based, often seemed meaningless and irrelevant to them. They largely accepted this, believing that teachers knew the most appropriate ways to increase learning, and that the mathematics would "get more interesting later on." Despite differences in their background, experiences, expectations, abilities and interests--all rich resources for learning--adult students were all required to perform the same work. Further, because little time was given over for discussion, they had few opportunities to debate how the mathematics they were learning could relate to their lives.

## Discussion

Interactions in mathematics classrooms must be viewed not only in educational and pedagogical terms, but also as social experiences. Within the classroom, students not only learn mathematics but also classroom norms about how to behave, how to learn, how to react to the demands of teaching and

assessment, how to pleas : teachers, as well as what they need to do to pass the course.

The findings of this study support the contention that adult learners in mathematics classrooms are largely socialized into believing that their own experiences, concerns, and purposes are of little value. Students' life situations are never asked about, or rarely acknowledged as potential examples of mathematics in use. In this way, life is subjugated to mathematics, teachers imply that anything students have to contribute is of little relevance or value, and the teacher's non-accountable and authoritarian role is emphasized. Further, because possession of mathematical knowledge is seen as governing learners' future occupational and economic roles, mathematics is used to instill the values that Western society regards as necessary in its workforce: individualism, passivity, obedience to authority, and competition. Thus, the social experience of the mathematics classroom is strangely paradoxical. On the one hand, students' actual life experiences are treated as irrelevant, while on the other, the teacher, the text, and the teaching methods promote an explicit set of experiences and problems as mathematically valid, appropriate and relevant. The values inherent in these may often be inappropriate or at odds with those actually held by the students. At the very least, learning mathematics is portrayed as the acceptance of, and obedience to, the authority of others, rather than as a process of discovery, awakening, or understanding. Contrast this with adult educators' approach to virtually any other subject area, and the rigidity of the approach towards mathematics is immediately apparent.

Basing teaching so closely on mathematics textbooks is questionable. First, textbooks often transform the subject matter in confusing and illogical ways. For example, mathematics is commonly presented as a hierarchical series of tiny sections to be mastered sequentially. Learners get few opportunities to discover how mathematical concepts are interrelated, or to practice their skills across a series of content areas. Second, teachers lose the opportunities to develop a richer understanding. Although textbooks aim to "enable students to thoroughly understand mathematical concepts"; such "understanding" often merely refers to students' abilities to successfully reproduce the textbook's definitions and procedures rather than any deeper understandings or insights. Students, thus, may develop what Skemp (1976) calls "instrumental" understanding--being able to follow rules--without ever developing any "relational" understanding--knowing both what to do and why. This inability to develop relational understanding creates the levels of adult innumeracy that so alarm government, business, and educational bodies.

Reinforcing a distinction between formal "classroom" mathematics and informal, "real-life" mathematics prevents students from encountering and dealing with examples and practices of mathematics in their own ways, or in ways that are appropriate to their own lives. When students are faced with a mathematical problem in the classroom they are encouraged to disregard their own experience, intuition, and existing problem-solving skills (which they would be expected to use if such a problem occurred in the real world) and, instead, to accurately follow the steps laid down in the textbook and explicated by the teacher. Solving "real life" mathematical problems involves the use of relational knowledge, mathematical intuition, and finding partial solutions, as much as the ability to calculate accurately and quickly. Yet these are precisely the skills not developed by a focus on individual motivation, not best developed by sequential one-rule memorization, and

not likely to arise from "pure" cognitive insights removed from the contexts of students' actual lives.

Thus, it would seem that the rigidity with which mathematics is conceptualized initiates a series of reactions. Teachers, believing that mathematics is complex, pure, and conceptually hierarchical, align themselves as interpreters of its truths rather than developers of students' insights. Texts, timetables, and tests are raised to an unexamined dominance in classroom management, and pedagogical problems become fixed and localized in individual students rather than in other arenas.

Finally, the effects of certain frames on teaching processes can be discerned. The institutional settings of adult education portray mathematics education as one part of a system of "lifelong education" that provide opportunities for individuals to engage in purposeful and systematic learning throughout their lives. However, within those settings, the mathematical curricula and pedagogies chosen reflect predominantly vocational concerns and often outdated notions of appropriate mathematical skills and knowledge. Certainly, the chosen textbooks (upon which so much of the teaching is based) carry quite different messages from those of educators, and promote dominant values of individualism, competition, passivity, and obedience to authority. Finally, the previous life and professional experiences of adult learners and teachers do not encourage critical examination of course methods or content. Teachers promote (and learners accept) the notion that hard work and motivation are sufficient; they will enable students to pass the courses. What is left unexamined and unacknowledged are the myriad circumstances and applications of mathematics to the real world.

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